Smart Cities and Data generation

Dealing with the High Information Volume in Urban Spaces

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Abstract— **The deepening of the concept of Smart Cities, where the technology is used intensively in the urban context, brings with it several challenges. The increase in the amount of information generated indicates that organizations responsible for analyzing this data need to use new methods of storage, integration and processing. This paper aims to synthesize the main paradigms that involve such issues of data analysis and processing, identifying general solutions to common challenges among agents who need to work with urban information.**

Keywords—Smart Cities; Big Data; Data Management;

I. Introduction

With the emergence of intensive use of technology in the context of cities, new concepts come to arise as a result of the impacts that this change entails in the daily lives of the populations. The main idea that appears in the midst of such paradigm shifts concerns the term "Smart Cities". This means that from that moment, new tools are beginning to be used to assist in the optimization of urban processes. For this to happen, therefore, it is necessary to implement an increasing amount of informational components in several layers of the cities so that data is generated in a way that enables future analysis processes. Such analyzes are done by organizations and policymakers so that it is possible to increase the quality of life in urban spaces, improving areas such as housing, transportation, environment, among others. However, the great problem that arises from this process has to do with how to handle all this information. A large amount of information is generated and new data storage, integration and analysis processes are needed.

II. Characteristics of Smart Cities

The concept of Smart City has different meanings, which may vary depending on whether the speaker is referring from the point of view of people or technology. [1] When regions around the world create proposals to become smart cities, the focus becomes different, making that aspect clear. But we still do not have a clear definition of what constitutes such a city, although it has been a subject much discussed around the world. It has been difficult to create a term that adds all the definitions of a smart city so that terminologies that serve all are created. Still, many of the most common explanations have similar characteristics, both in terms of their form and the things they offer. The most common proposal concerns the increase in the quality of life of the citizens of a certain locality, providing this through the use of information technology, with hardware, software and intensive use of data to offer services that aim to solve daily challenges of the cities. It is also possible to report such issues with environmental observations, identifying natural resources, or transport, public health, education, energy, public safety or even help governments to be more efficient. There are many different definitions regarding the focus that a smart city should have. It is possible, for example, to understand the concept as a way to integrate more efficient constructions, with the good use of energy and integrated transport as an ideal way to increase the quality of life of the populations. Proposals for the future of the next generations also become important as they also focus on the sustainability aspects of existing development models. [1] However governments tend to be concerned about the implementation of this new model, worrying mostly about the costs involved in an smart city, since resources are generally scarce for such initiatives. This happens both in relation to the environment and in directly human issues. The availability of resources for such investments is the main challenge in implementing an smart city. In addition, it is necessary to concern with the legal mechanisms that have enabled the actual functioning of an smart model. Without such a mechanism, such an initiative would probably not work properly. Finally, just as important is the technology layer, where new solutions need to be proposed. More advanced technologies are needed in this context, requiring the application of an increasing number of technical ideas in the urban environment. If used in an integrated way, there is a great opportunity to create resolutions for common challenges in the cities, improving the quality of life of all who inhabit it.

III.   How Data Works in the City

In the context of a city, the data is generated from several different sources. From that point, it is possible to affirm that the joining of several data of these constitutes the Big Data. There are countless sources of these around us. Mobile Phones, GPS (Geo-graphical Positioning Systems), computers, environmental sensors, traffic sensors, among others. With the advance of the daily use of technologies, the amount of data that has been generated has increased significantly.

There are several possible ways to classify Big Data. However, it is possible to generalize the idea behind the term. For Big Data, it is possible to state that it is a set of data that can belong to different people and are stored and processed in different ways. In addition there are several possibilities for this data, with advanced uses to understand paradigms behind them, such as the use of data mining, data analytics, artificial intelligence application, to name a few. [2]

To be able to support Big Data analyzes, the cloud appeared as an important tool because it proved to be efficient for this utility. Resource-intensive tools found in the cloud an opportunity to develop properly. Taking into account also the possibility of interoperability between applications, the cloud processing fits very well with the definition of smart city.

Cities then have great possibilities to solve their challenges through the use of technology. Through tools that enable the mass analysis of information, the breadth of data generated by this type of environment can go through more refined treatments to aid in decision making. Policymakers can then build on this new view of data and propose better services or urban changes.

The management of Big Data can be described through some specific terms. Among them is volume, speed, variety, variability, value, volatility, validity and truthfulness. All of these terms describe characteristics of a Big Data system and depict how that data needs to be made available and organized. [2]

These various features cited in relation to Big Data demonstrate how there are several opportunities for use of the tool. If applied properly, smart cities can become the ones that take the most advantage of such data sets. Therefore, understanding advantages and limitations, we can better understand the possible applications in urban environments.

Another aspect that needs to be considered is the sharing of information within the city. Different government agencies have access to and produce different data from one another. Most of the time they store the data in their own Data Warehouses and have specific privacy policies, making it difficult to access that data. The same applies to other types of organizations as companies. When it comes to sensitive data the challenge becomes a bit greater as the data needs to be opened to assist in the analysis to be made. [3]

Data quality is often diverse in most cases. Such data are stored and produced in a variety of formats, making it difficult to subsequently process this information. As there is no heterogeneity or similar semantics between the data it is unlikely that there is an automated process to integrate such data.

In addition there are other equally important factors in this sense of what is being addressed. Security is the first of them, which becomes one of the essential factors, especially in what concerns the privacy of people. The cost of a project of the type, and it is necessary for those who will make the implementations to verify the feasibility of this system. And finally, the size of the population that will make use of these solutions, since more individuals require more data analysis consequently.

Big Data applications for smart cities often float between two types, that is, offline applications and those that are online and run in real time. For this second type the processing capacity needs to be much larger in order to handle the information load it is being subjected to.

It is also possible to speak of other technical factors that directly influence the processing and storage of data in urban spaces. One of these factors concerns the management of Big Data. To do this kind of management it becomes important that the right tools for this be available. Big Data management is directly related to the policies, execution of architecture, practices and procedures that deal with the information lifecycle in a smart city application. [2]

Likewise, it is necessary to use Big Data processing platforms. In the case of smart cities mainly, the processing capacity needs to be very large. Such platforms need to be stable, reliable, scalable and need to work in high performance. Technologies such as Hadoop Mapreduce [4] and IBM Inforphere Streams [5] are known to work on clustering systems, optimizing operations for Big Data activities. Another possibility would be to use a cloud tool, such as Amazon AWS [6], which has dedicated instances for this.

A key factor, especially for smart cities applications made in real time, is the network infrastructure for communications to be made between the connected devices. Ensuring that the information collected will arrive quickly may be essential to the success of a given operation.

However, existing tools will not always be sufficient for application in a particular system. In this case, there is a need to implement more advanced algorithms to customize solutions at certain times. Similarly, the use of data usage patterns can facilitate the upgrade or maintenance of systems.

Finally, it is interesting to note that this section is only a brief account of the main issues involving data generated by

an smart city. Handling large amounts of data is always challenging, even for people already working with such technologies. There are many aspects to be followed and it is important to verify the reality of each locality. The great challenge, then, is to implement these ideas, so that this whole information framework will actually guide the development of the cities.

IV.   Discussion

Although a worldwide trend can be observed regarding smart cities, its definition is not yet unified among the people who study the subject. Although such an observation is not clear to all, there are some perceptions that also seem to be general. There are ideas that a smart city will improve the quality of life of its citizens by improving the socio-economic conditions of a given locality, creating more sustainable infrastructure in cities. In addition, there are several other features that are included in the definition, such as the intensive use of information and communication technologies, integrating different parts of urban life. Applications can be created to monitor different aspects of cities, improving the efficiency and quality of these areas, creating a better sustainability of all the systems involved.

All smart city proposals are affected by these features discussed regardless of their size. However governments tend to postpone the implementation of this type of model because they fear the costs and regulatory aspects involved. What can then help mitigate such problems lies in the technological advance.

One of the areas that are becoming of great importance has to do with the observance of Big Data technology. There is a great opportunity in using the tool to observe the data generated by the cities, creating better analyzes for more appropriate decision making. Cloud applications, likewise, bring new collaborative solutions in smart cities by applying information and communication technologies in their context. The joining of these information technologies with cloud tools and Big Data opens up great new opportunities for urban analysis, in volumes much larger than ever before.

The understanding of Big Data is the fundamental point for the functioning of an smart city. However, working with such a large volume of information becomes challenging because of the inherent complexity of this type of model. Analyzing, storing and collecting such data becomes a very complicated task when dealing with such large spaces. The use of Big Data, therefore, brings several new opportunities for analysis of urban challenges, thus facilitating the decision-making of the most diverse types of social agents.

The correct application of the concepts of Big Data in a city thus has a direct correlation to exemplify how smart this city really is. Understanding how smart cities work is the first step in integrating Big Data with information technology to generate smart applications. From then policymakers can begin to make decisions to build better cities to live and more sustainable.

Finally, the implementation of the smart cities model requires the efforts of public authorities to include this perspective in their work plans. There is a need to plan the city to solve its problems and challenges from the technological point of view by optimizing the decision-making of managers. Investments in public infrastructure and research and development become essential in this process. Then, by integrating data and systems, it will be possible to have an overview of how to provide a better quality of life for the inhabitants of a certain region, respecting the environment and the socioeconomic conditions of that place.

V.   Conclusion

In this paper we discuss the characteristics of the so-called Smart Cities in which we understand that this term is due to the technological characteristics employed in these spaces, which brings several new challenges to managers and policymakers. But the main purpose of this work, beyond that, is to talk about data generation.

In addition, the challenge of increasing the amount of data that needs to be stored, integrated and analyzed was addressed directly. With increasing information generation from different sources this process becomes increasingly complex.

This way it is necessary to observe that in addition to the urban planning *per se*, it is also important from that moment on to have clear data processing and analysis standards, in order to guide the decision-making of policymakers and managers who work to bring solutions to the urban challenges.

By taking note of all these characteristics, it would be possible to create increasingly sustainable urban environments that are concerned with the human, environmental and economic aspects that are part of the whole scenario that cities represent around the world.

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